

Engineering Management

Field Project

A Study of Wireless Computing and a Design for a Wireless System in Bars and Restaurants

By

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This paper is dedicated to my wife Kate, my son Rory, and my daughter Naomi who have given me the inspiration and support to achieve my educational goals.

This paper is also dedicated to my mother Pam who has committed her life to the education of young people and who taught me to be a lifelong learner.

Executive Summary

This paper provides an insight into the use of wireless computing and how it can be used in one specific service industry, restaurants and bars. It answers some of the questions as to how these computer networks are already being used and how they may be used in the future. The bulk of the information presented in the work comes directly from a survey of people who represent the restaurant and bar customer base. The results of this survey show how prevalent wireless computing is and that, for the most part, people are accustomed to the idea of using computers in almost every aspect of their daily lives. It also shows how different wireless use is by gender, age, and geographic location.

Secondly, this project proposes a design for a wireless network for a restaurant located in Overland Park, KS using off the shelf hardware and technologies that are available at most common electronics retailers. The design focuses on providing the greatest value to the operation by increasing both customer satisfaction and employee productivity. Customer satisfaction is improved by delivering a higher level of personal service and making available as much relevant information as possible. Employee productivity is improved by empowering employees with information and the means to deliver services accurately and efficiently.

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Chapter 1 Introduction

As computers, and more recently the Internet, have become a common component in our modern lives, the tasks that we have come to depend on them to do have become increasingly intertwined in our ability to interact within society. No longer are computers used just for solving complex equations or modeling otherwise unimaginable systems. Now, we use computers to keep track of our contacts, schedule our appointments, send messages, post photographs, provide driving directions, and even to maintain our most important relationships. Wireless computing is the complete integration of computing with everyday objects and activities to the point that people may be unaware of the systems with which they interact.

While this notion of pervasive computing has already penetrated some customer facing industries such as automobiles and telecommunications, current interactions between computer networks and retail customers are usually obvious if not painful. Getting customers to try self-checkout is only the first hurdle. If a customer is unable to complete a transaction at a self-checkout lane, they may abandon their purchase altogether and will probably be less likely to use one in the future.

Probably the most common example of pervasive computing is modern automobiles. Most people (with good reason) have no idea how many integrated computer systems are operating during the act of driving their car. Stringer,

Halloran, Hornecker, and Fitzpatrick explain it this way, “Here, technology is employed not only in the car to ensure smooth running of the engine and safe braking but also in the traffic lights which control the movement of the car down the road and in the command and control systems which ensure that there is fuel in the pumps at the petrol station.”[1] All of these systems, although separate and independent, work together during the act of navigating a vehicle from point A to point B safely and orderly.

The point to take from this example is not merely that people depend on computers to manage their daily lives but how much we take it for granted and don’t realize the true number of interactions with computers. Webster’s dictionary defines pervasive as, “existing or being everywhere at the same time”. Clearly, the term Pervasive Computing cannot quite live up to its literal meaning but the notion that computers are “everywhere” is a feeling to which many of us can relate. In fact, the suspicion of the trust placed in computers to manage our lives has been the topic of many popular movies where computers have taken over our society. This suggests that evolution of computer networks has already become deeply integrated into our society through literature and other means.

This study does not aim to judge whether modern dependence on computers is good or bad. Rather, it aims to determine to what degree computers have already penetrated one aspect of our lives and what expectations consumers may have for the future. Bars and restaurants have been chosen for several reasons. First, they are places where members from all demographics from our

society frequent on a regular basis. Second, they are places where people are free to choose how they spend their time and money within a fixed set of options. These options include eating & drinking, entertainment, socialization, and business.. Third, the restaurant and bar industry is well established and can be studied from a historical reference when it comes to before and after computers entered the scene. Finally, the industry focuses on building a clientele by providing its customers with many options in hopes of repeat business.

While the use of computers in bars and restaurants comes in many forms, there are two distinct user groups; employees and customers. The wireless technology requirements for these two groups are completely different and therefore serve as broad territory from which to study. The business and its employees use wireless technology to track sales, fill orders, and bill customers. The customers are all about entertainment and information whether it be watching television or playing trivia. There is also a region where the two sides have the same requirements such as ease of use, data bandwidth, and speed.

This paper gathers information directly patrons of restaurants and bars using an online survey. The focus of the survey is to determine if people are comfortable using wireless technology to view specials, order food and drinks, and pay their bill. A review of the results of this survey shows some interesting trends that reveal who is most likely to embrace a wireless environment.

Finally, this paper puts forth one possible design for a wireless network geared toward using the latest off-the-shelf technology available in most

electronics stores. The design of this network will emphasize leveraging these wireless technologies to serve customers in a totally new way and at a higher level. By organizing and prioritizing information in ways that were not possible until now, this design aims to increase order accuracy, reduce preparation time, improve server availability, and streamline the payment process. The design also includes a different approach to staffing and job responsibilities. A cost analysis is given to study what level of investment is required to implement this approach and how to evaluate the returns on that investment.

At its conclusion, this paper hopes to have shed some light on the business reasons behind investing in and using new technologies for tasks that have so far been widely unaffected by the “information revolution” of the past decade. Are wireless networks a requirement for running a restaurant? No. Are wireless networks a customer expectation? If not, they soon may be. And this reason, maybe more than any other, could be what drives the industry to adopt new standards of service. Imagine never having to wonder where your waiter has gone or never having to ask what the special of the day is or knowing exactly how much you have spent before you ask for the bill. All of these become possible when computers are truly allowed to penetrate every level of the retail process.

Chapter 2 Literature Review

Wireless Networks & Pervasive Computing

Wireless networks have become prevalent all over the developed world. Every city on earth depends on multiple methods of wireless communication to keep their businesses and even their society running smoothly. This literature review will discuss the evolution of wireless networks and their current forms and functions. Special emphasis will be given to how these networks are used to transact business, particularly in the food service industry.

In the paper “Pervasive Computing: Paradigm for New Era Computing”, Dhingra and Arora define three eras or “waves” of computing;

First Wave – Mainframe computing era: one computer shared by many people, via workstations.

Second Wave – Personal computing era: one computer used by one person, requiring a conscious interaction. Users largely bound to desktop.

Third Wave – Pervasive (initially called ubiquitous) computing era: one person, many computers. Millions of computers embedded in the environment, allowing technology to recede into the background.[2]

Dhingra and Arora have done a good job of clearly defining three very distinct eras. With each of these eras, the impact was absorbed into mainstream society more easily. During the first wave, roughly from the 1950's through the

1970's, computers were very large, mysterious machines that required specialized skills to operate and understand. Common people were very detached from their use and may not have even understood the basic concepts behind their operation. Still, the people who did understand how to use them were so infatuated that they strived to create smaller versions that they could use in their own home on their own time. This finally brought about the introduction of the personal computer in the late 1970's and later the first widespread use with the appearance of the Apple Macintosh in 1984.

The second wave (the personal computing era) is when computers started to take on a life of their own. By bringing them into their homes, people could use them however they wanted and for as long as they wanted. All of the sudden, a vast resource of untrained but eager-to-learn users were unleashed on a technology like never before in history. This era was capped by the wide spread use of broadband internet in the early 2000's. The second wave was capped because of the caveat "users largely bound to desktop" in Dhingra and Arora's description.

The third wave (the pervasive computing era) has only just begun. With the clear dominance of mobile over desktop devices, the restriction of the "desktop" has been removed. "One person, many computers" seems to be the environment that most of the developed world (certainly the United States) lives in. Even the requirement of "millions of computers embedded in the environment" can be rationalized by pointing out that in large cities, with millions

of people; there are literally millions of computers all around. As Lee and Lee state, "Thus 'anytime anywhere' goal of mobile computing has been turned to 'all the time everywhere' goal for pervasive computing." [3] The only remaining requirement given by Dhingra and Arora yet to occur is, "allowing technology to recede into the background". It is, at times, painfully obvious that technology is very much in the forefront of our society rather than behaving quietly behind it.

Now that we can say that we are close to this environment of pervasive computing, how does it affect our lives? In the article, Philosophy, Privacy, and Pervasive Computing, Michelfelder considers one of the hot-button topics of modern technology, privacy. She raises a good point when she says, "pervasive computing raises threats to individual privacy by limiting an individual's ability to decide for him- or herself whether or not to be a provider of technological information in the first place." [4] There are many pieces of personal information that not long ago were guarded much more closely. Credit card numbers, bank statements, personal correspondence and medical records are just a few examples. Now, this information is passed around electronically on a daily basis and in some cases without our knowledge.

In fact, we may not even be totally aware of the volume of information being collected. For example, when we use a retail loyalty card the items we purchase can be directly tracked to the card, which in turn is linked to a household, which in turn is a part of a neighborhood, which in turn is part of a city. All of the sudden, retailers have detailed and accurate information on

customer demographics like never before in history. To take it a step further, Michelfelder suggests a plausible scenario:

On my cell phone, I have turned on an application that connects my daily “to-do” list with GPS technology. As I am driving home from work and near the vicinity of a video store, my cell phone sends me an auditory reminder that I should stop. It also sends a customer service representative at the store a list of the DVDs I am interested in viewing. By the time I reach the store, the DVDs have been assembled, charged to my account, and ready for me to take home to view.[4]

The important difference between this scenario and almost any other retail technology is the lack of action required by the customer. All she had to do was put a task on her “to-do” list and her phone took care of the rest. Another way to think about it is what if she had taken a different route home from work? Perhaps she would not have passed a video store until later that week when she would have been notified that her order had been placed. This is the true goal of pervasive computing, computers working within your environment and not as an added burden.

Wireless Retail

Working within your environment can apply to the infrastructure side of networks as well. In the article “Preparing to Ride the Wireless Wave” from 2001, Barbero forecasted “that the U.S. mobile commerce market will result in

almost \$21 billion in transactions in just four years”.^[5] This seems like a conservative projection since the United States Census Bureau reported \$996 billion in e-commerce transactions in 2004 which would require only 2% be mobile transactions. Barbero goes on to point out, “... in emerging markets such as Latin America, China, and the Pacific Rim. Due to the prohibitive costs of rolling out wire line, portable devices may be the only way to connect remote employees and companies in these areas.” When you consider that nearly one-half of the world’s population is in China and India, this observation becomes even more astute. For almost this entire population, their first computer will not have a keyboard or mouse but will fit in their pocket, almost as an afterthought.

Another quality of wireless computing is the added value it delivers. That is to say, the kind of feature that makes you say “how did I ever get along without this?” Cell phones are an easy and obvious example. Another is the SkyBOX system by Vivid Sky as described by Tim Hayden in his article “Empowering Sports Fans with Technology”. Hayden writes, “Fans attending a game can tap in to a wireless network from anywhere in the stadium using a handheld device that, among other things, will let them view on-demand instant replays from various cameras; ...order food and merchandise; ... [and] check traffic for the drive home.”^[6]

Clearly, this is not the same baseball game experience that most people born before 2000 remember from their childhood. Technology has changed the expectations of entertainment. No longer is it enough to see a great play, but

now that play is expected to be reviewable by anyone at anytime from anywhere and if it is not, it's almost like it didn't happen. As Hayden's description illustrates, technology has also changed the way merchandise is sold. It may no longer be as important to have a clean well organized store as it is to have an appealing and easy to navigate website.

This brings us directly to the topic of local wireless networks in retail sales. The most widely used and growing form of wireless is point of sale systems. As Kingson states in her New York Times article, "Wireless Moves the Cash Register Where You Are", "Plumbers, limousine drivers, flea market proprietors and merchants of all sizes and stripes are beginning to take credit and debit cards in odd places, often using nothing more than an ordinary cell phone and a card swipe attachment, or a handheld device with a built-in swipe slot." [7] Almost any business can benefit from off the shelf equipment and easy to access software of mobile applications.

However, not all forays into wireless are a success. Kingson goes on to report, "Domino's Pizza has experimented with wireless terminals and has so far rejected them. "We found in the early tests it was hard for drivers to drive if they had these things on their belts," said Tim McIntyre, a spokesman for Domino's. "In the course of working in a car and a pizza store, some of these things weren't as durable as they needed to be, and once they were manufactured to be durable enough, they were no longer cost-effective." [7] Clearly, the requirements of the business need to be in line with the technology.

A positive example is brought up by Yih, Pinel, and Chieu in their paper “Pervasive Computing Technologies for Retail In-store Shopping”. “With the use of pervasive technologies and an integrated in-store server network, collaborative shopping becomes possible in the store environment. For example, a couple can shop simultaneously by sharing the status of a dynamic shopping list without duplicating purchases.”[9]

Here is a case of technology solving a problem that was created, ironically, by expectations of technology itself. Before collaborative applications were available, the same couple would have just split the list in half and gone their separate ways. But what if an item on person A’s list is cheaper at the store person B is shopping? Or, what if an item is out of stock, or isn’t the desired brand, or doesn’t come in the right color? All of these issues are solved by sharing information, not just between the shoppers but also with the stores. Now everyone knows what to others know, to the degree that they want to share the information.

One study that has much in common with this project is “PDA-Based Wireless Food Ordering System for Hospitality Industry – A Case Study of Box Hill Institute” by Patel, Patel, and Obersnel. They list advantages of wireless technologies in restaurants as, “increased efficiency, greater speed of service, enhanced usability, improved accuracy, increased productivity and higher business profile.”[10] These are the same advantages that will be emphasized in the design created for this project. Increased efficiency and greater speed of

service come from the fact that some actions are not repeated; like writing down an order and then entering that same information into the computer. Enhanced usability could come from a dynamic ordering interface where the most common items are presented first. Improved accuracy and increased productivity is a result of immediately entering and receiving orders. And higher business profile means that customers perceive the other advantages on some level and want to come back.

Business to Business

So far, we have discussed research that concerns transaction between customers and retailers, but what about transactions between retailers and suppliers? For bars and restaurants, Meulstee and Pechenizkiy offer this insight, "In the food and beverages market, food service companies have to deal often with short shelf-life products, and uncertainty and fluctuations in consumer demands." [11] It is vital to the success of a restaurant to be able to accurately order supplies. Too much and some will be lost to spoilage, too little and you will run out of the special of the day before lunch is over. In this context, being able to predict what your customers are going to do is not only a great advantage over competitors but also a vital component of day to day operations.

Some solutions that address this need approach the problem with a JIT (just-in-time) ordering system. As orders are filled, the system is able to determine what supplies need to be replenished for the next day. In addition, trends are identified that may overtly impact demand. For instance, a common

seasonal effect is the Catholic observance of lent in which only fish is eaten on Fridays. During this time, a restaurant may order more fish and less steak, pork, and chicken or in the case of a seafood restaurant, more of everything. These fluctuations do not have to be external as in the case of daily specials or planned events. If Wednesday is wing day, extra cases will automatically be ordered.

Meulstee and Pechenizkiy go on to say, "Furthermore, a large share of the products sold in that market is sensitive to some form of seasonal change due to the different cultural habits, religious holidays, fasting and alike. All these factors imply that some types of products are sold mostly during the limited period(s) of time." [11] This is exactly the type of situation that pervasive computing is expected to shine. Computers and application adapt to people and their environment, not the other way around.

Technology Abuse & Security

An early example of entry into retail is discussed in "Case study on Retail Customer Communication Applying Ubiquitous Computing" by Strüker, Sackmann, and Müller. This case study looks at a PSA (Personal Shopping Assistant) system used in European grocery stores from the point of view of its effect on buying habits and price discrimination. They describe price discrimination by saying, "The goal is either the exploitation of customers' differing willingness-to-pay at different points of time, or to increase the sale of, say, remaining stock or perishable goods on the verge of closing time." [8]

Price discrimination is one of the possible evils of pervasive computing for consumers. The idea is that if a retailer knows that you always buy the same brand of toothpaste, you will probably still buy it even if it costs more than all the other brands. Or if the temperature outside is 90 degrees, people will probably pay more for a soft drink from a vending machine. In the past, this was not an issue because prices are determined in advance and clearly marked on products. But in a computer centric, barcode world, prices can be changed instantly and as often as desired. Ideally, this could also be an advantage for consumers because they are able to compare prices from many different retailers without every actually going into a store.

One of the important topics when discussing anything to do with wireless networks and money is security. The more information is passed through the air, the more likely it is that someone may intercept or receive that information by mistake. In an article titled "Setting new standards: changes are coming to the world of WiFi, where safer and speedier wins the race" Wendy Cretien points out, "... WiFi is, by default, a shared medium. All users who are connected to a single access point share the bandwidth available through that [access point]. This is unlike switched wired networks, in which every user has a dedicated amount of bandwidth. "[12] Sharing bandwidth is inescapable by the very nature of the wireless medium.

The level of security must be agreed upon by everyone involved in designing and manufacturing the hardware and software. This topic was tackled

in earnest by the IEEE in 2004 with the definition of the WiFi Protected Access (WPA2) protocol. Cretien goes on to say, “WPA2 provides network administrators with a high level of assurance that only authorized users can access the network.”[12] And Mark Ciampa detail in his book, “CWNA Guide to Wireless LANs” that “WPA2 was designed to replace the weaker Wired Equivalent Privacy (WEP) protocol by implementing the mandatory requirements of 802.11i including CCMP, a new AES-based encryption protocol.”[13]

Wireless Technology & Restaurants

What are we really talking about here? Experimenting with new technologies purely for the advancement of science and the search for knowledge? The answer is, of course, no. Businesses are only interested in new ideas that mean increased profit. What we really want to know is; how will these new systems translate into real value? It all depends on how you measure that value.

For a large corporation like McDonalds, the goal was to get more customers out of the drive through and into the restaurant. “When the first Wi-Fi pilot started, 60% of McDonald’s business was done at the drive-through window, and people who came inside only because the drive-through line was too long accounted for a big chunk of the remaining 40%.”[14] McDonald’s problem wasn’t getting customers. It was getting their customers to spend more time in the restaurant and hopefully pick up an extra order of fries or an apple pie on the way out.

For a smaller restaurant called The Bazaar in Beverly, Hills California the goal was improving a fine dining experience. “The efficiency of our servers is higher now and they spend more time on the service floor, ... because to enter orders they do not need to move back and forth between fixed POS terminals and their sections. Also, he noted, ‘they’re more interactive with the guests.’”[15] By removing some of the traditional responsibilities of the server, The Bazaar seeks to give its customers a level of service that they cannot find elsewhere. “A ‘not-so-talked-about benefit’ ... is the cost savings. It takes less staff to care for the guest now.” This is the type of benefit that any owner or manager can immediately comprehend reduction in staff requirements.

In both of these examples, wireless technology shows its flexibility to address different types of problems for different businesses. The continued evolution of wireless is the key to its potential in almost any situation. Of course, there are pitfalls such as increased power consumption and relying too heavily on technology but the promised advantages seem to outweigh the drawbacks. Let’s face it, the world has already moved rapidly toward wireless technology and using computers at almost every opportunity. At this point, the use of wireless networks in restaurants and bars is inevitable.

Let’s look at three more examples of the use of wireless technology in restaurants that do not include point of sale systems. The article “Starbucks, iTunes team for in-coffeehouse downloads” describes a “wireless” marketing promotion, “The now playing feature allows customers to preview, buy and do

real-time downloads of music playing in the Starbucks locations via Wi-Fi connections to their laptops and portable devices.”[16] In this example, Starbucks and Apple (iTunes) are teaming up to deliver a marketing campaign that few other companies could reproduce. Apple supplies the bulk of the technology infrastructure, namely wireless mobile devices, and Starbucks brings the customers in through their stores. It's a win, win for both sides enabling Starbucks to entice its customers to stay longer and come back more often and generating more iTunes traffic for Apple.

The area of customer satisfaction can also be addressed using technology. In an article by Julie Ritzer, she describes the use of electronic customer comment cards used by BD's Mongolian Barbeque. “Delivered to diners along with their checks, the devices store collected information until the end of the working day ... With a secure Internet connection; data are uploaded via the terminal to the vendor's password protected website for compilation into daily reports.”[17] This system not only makes data collection easier but the results are delivered faster and more conveniently. Customers may be more likely to participate in the survey since they only have to push a few buttons.

Up to now, this paper has focused mainly on the front of house operations of the restaurant industry. However, the behind the scenes operations may be the most straight forward place to increase the use of technology. In the article “Foodservice equipment trends: Professionals eye future ‘computer kitchen’”, Rocky Brock from Applebee's International discusses some of the potential uses

of technology in kitchen equipment. “The idea of being able to diagnose a problem with a piece of equipment from the service agent’s or manufacturer’s office by accessing the piece of equipment via modem could save service costs and overall equipment downtime.”[18] Even broilers, fryers, and grills have already become components of the internet. This example truly brings home the point of pervasive computing.

Now we have a good grasp on where wireless communication has been and an idea of how it is being used in restaurants and bars. This literature review has shown the potential and actual uses of wireless technology leading ever closer to a pervasive state. Without the need for wires, computers and other devices have become free to penetrate nearly every aspect of our lives. From here, we can begin to focus on the feasibility of increasing the use of technology in a restaurant environment.

Chapter 3 Procedure and Methodology

There are two separate components that make up this field project. The first is a random survey of adults over the age of 18 in order to gauge the current wireless landscape that was administered online. The second component is a proposal for a wireless network for a local restaurant located in Overland Park, Kansas.

Survey Procedure

The survey consisted of 25 questions focusing on wireless internet use on networks provided by retail businesses. Most of the questions dealt with the use of smart phones and other portable devices. Participants were asked a different set of questions depending on their past experience with Wi-Fi networks. The goal of the survey was to gauge current usage patterns and possible future expectations of people from multiple demographic groups.

The survey was administered online using a Google form which enabled the responses to be directly recorded in a spreadsheet that was exported and processed with Microsoft Excel. Depending on their answer to the first question, “Have you ever used a Wi-Fi service offered by a public business?”, participants were presented with four different questions followed by twenty common questions. Therefore, participants answered 21 of the 25 questions.

The reason for this approach was to gather information from different points of view. Those who answered “yes” were asked follow up questions focusing on what they liked about Wi-Fi service and how it affected their views toward businesses that offered them. Those who answered “no” were asked follow up questions on why they choose not to use these services. Finally, the remaining common questions were designed to gather information on overall technical knowledge or perception of technology as well as demographic information such as gender, age, and location.

Here are the questions that were presented (all questions are yes/no unless otherwise noted);

- Have you ever use a Wi-Fi service offered by a public business?

If answered “yes” to first question.

- Do you sometimes choose a business because the offer Wi-Fi service?
- Do you find you spend a longer period of time at businesses that offer Wi-Fi service?
- Do you find that you purchase more products at businesses that offer Wi-Fi service?
- If a business stopped offering Wi-Fi service, could it cause you to go elsewhere?

If answered “no” to first question.

- Do you sometimes choose a business because you know they do not offer Wi-Fi service?
- Do you think you would use Wi-Fi service if you knew more about how it works?
- Do you feel that public Wi-Fi services are unnecessary and a waste of time?
- If a business started offering Wi-Fi service, could it cause you to go elsewhere?

All participants were asked the following questions.

- Do you feel that most public Wi-Fi services are secure?
- Do you feel distracted or annoyed by people using laptops or smartphones in public places?
- Do you own a personal computer and use the internet at home?
- Do you own a smartphone or similar device? (Multiple choice with device type for six common devices, no, and other. Choose all that apply.)
- If you own a smartphone, what do you use it for most? (Business or personal)

- In general, how valuable do you feel that public Wi-Fi service is to your overall customer satisfaction? (Rating scale from 1 to 5 where 1="Not at all" and 5="Very valuable")
- How important to you is ordering products from a live person (Rating scale from 1 to 5 where 1="Website" and 5="Live Person")
- How likely would you be to use a computer to order food in a restaurant? (Rating scale from 1 to 5 where 1="Never" and 5="Always")
- How often do you eat out? ("Less than once a month", "One or two times a month", "Once a week", or "More than once a week")
- How often do you go out for an adult beverage? ("Less than once a month", "One or two times a month", "Once a week", or "More than once a week")
- How old are you? ("18-24 yrs", "25-35 yrs", "36-50 yrs", "51-65 yrs", or "66 yrs or older")
- What is your gender? ("Male" or "Female")
- What is your general occupation? ("Student", "Education", "Business", "Sci-Tech", "Service", "Craftsman", "Humanitarian", "Medical", "Other")

- What is your gross yearly pay? (“\$0-\$9,999”, “\$10,000 o \$24,999”, “\$25,000-\$49,999”, “\$50,000-\$74,999”, “\$75,000-\$99,999”, “\$100,000 or more”) *Optional
- Where do you live? (“U.S. East Coast”, “U.S. Midwest”, “U.S. West Coast”, “Somewhere Else”)
- Would you like to share any thoughts, good or bad, about using wireless technology? (Freeform text)

In all, 175 responses were gathered for the survey. All demographic groups were covered although most responses came from people who are between 26 and 65 years old and who live in the U.S. Midwest. The results were analyzed using Microsoft Excel. The main method of analysis was charting the overall results and then charting the results broken down by demographic segments.

Wireless Network Design Research

The design for a wireless network for Restaurant X was accomplished by studying the physical layout of the restaurant and by interviewing one of the owners to gather information on “pain points” that a wireless system could address. The network was designed with two sets of requirements in mind, the requirements of the business in order to increase productivity and the requirements of the customers in order to improve customer satisfaction and promote repeat business. Both of these goals aim to support the overall goal for any business, to increase profitability.

Restaurant X was chosen because of a personal relationship with one of the owners who is a childhood friend of the author's wife and the author has known him for over 10 years. He has been co-owner of the business for five years which makes him an expert of its operation. He was generous enough to not only speak with me on the day to day operation of his business but to also share with me some of the details behind running a successful restaurant.

In addition to the specific details of the restaurant, researched was conducted on non-proprietary hardware that is available for purchase from retail or online sources. The idea behind this approach is to create a design that does not depend on any one specific vendor. In fact, the only specialized component is the software that would be produced for the system. All of the hardware was chosen with the express intent that it could be replaced quickly and easily from "off the shelf" sources.

Chapter 4 Results

The results of this field project will be presented in two sections. The first section will be an analysis of the survey data. The second will be a design for a wireless system for a restaurant located in Overland Park, Kansas.

Survey Results

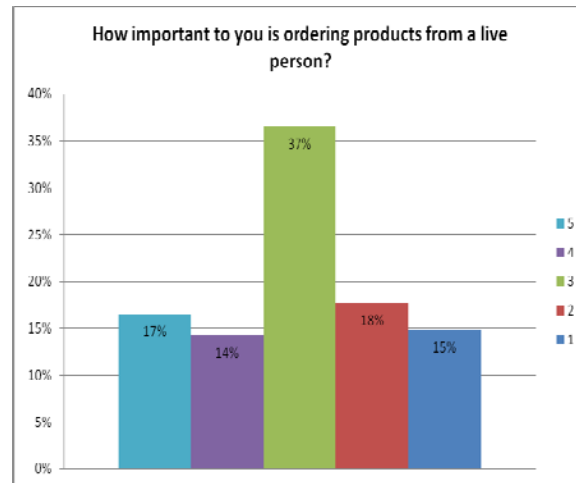
The survey was completed online by 175 people, 81 men and 94 women. 129 of these people had previous experience using Wi-Fi network offered by public businesses and 107 own some type of smart phone. 92% (154) were between the ages of 25 and 65. 85% of the responses came from people living in the U.S. Midwest, 7% were from the U.S. West Coast, 3% from the U.S. East Coast, and 4% were from outside the United States.

In the following pages, we will review some of the results of the survey by comparing answers broken down by four different parameters. These parameters are gender, age, geographic location, and frequency of eating out. Some of the questions showed no impact by these parameters while other questions highlight large difference in the way people use technology, especially by gender.

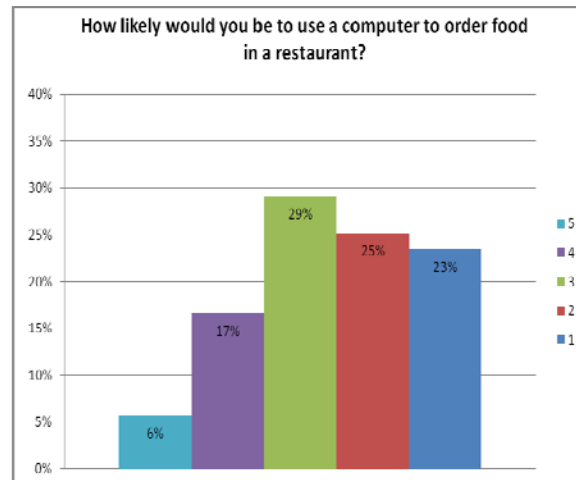
Let's consider the most important topic first. How comfortable are people with the concept of ordering their food using a computer. This topic can be

studied from two points of view which the following questions were intended to address.

Questions 12 & 13



This question sought to discover how comfortable people are with using machines to purchase products rather than interacting with another person. Perhaps not surprisingly, the results are somewhat difficult to decipher. The chart above shows that there are almost an equal amount of people who are comfortable ordering products using a computer as those who prefer to interact with a person. The most interesting result is that 37% responded that they really don't have an opinion either way. This is more than twice as much as any other rating.



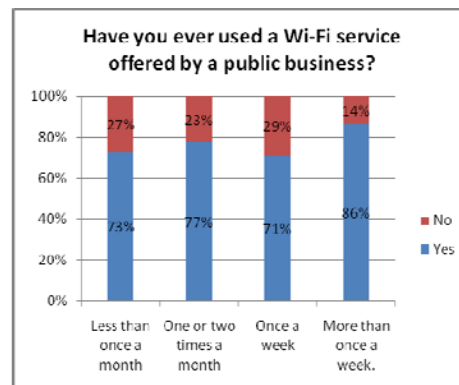
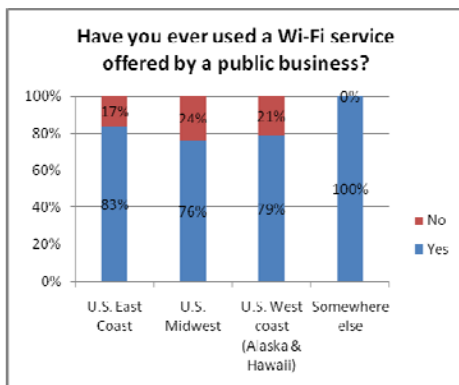
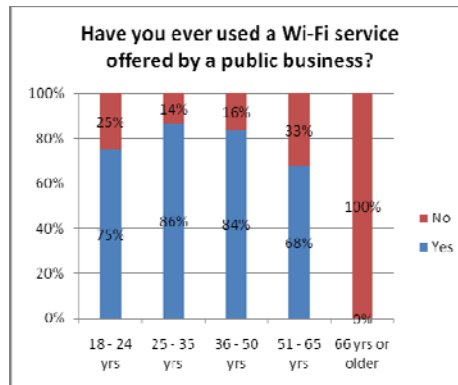
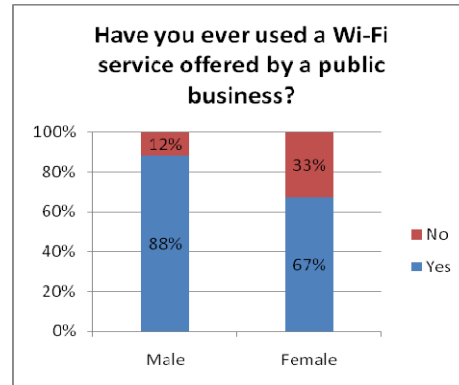
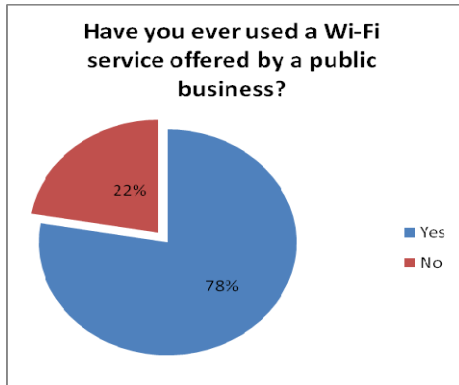
This question gets right to the heart of the topic of this field project, using computers to order food in bars and restaurants. Unfortunately, the results show that it may take time for most customers to become comfortable with this concept. While the most frequent rating is 3, which seems to say that most people wouldn't mind, there are far more who responded with lower ratings of 1 and 2 than higher ratings of 4 and 5. In fact, twice as many people (48%) responded with ratings lower than 3 compared to those who gave ratings higher than 3 (23%).

These results do not signify a death knell for computerized self-ordering in restaurants. Rather, they show that it will take some time and effort to introduce these concepts and see real acceptance by customers. This main focus of this effort should be to deliver an experience far and above that which most customers expect.

Since the data is not able to indicate a decisive verdict on customer acceptance of computer ordering, a more detailed look at how people use

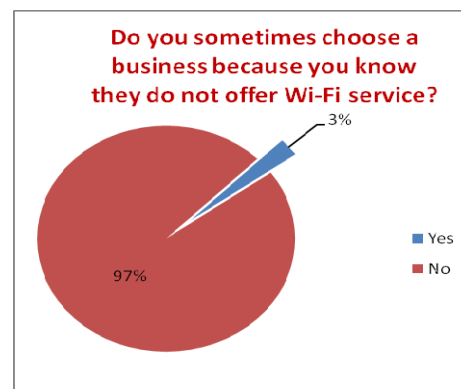
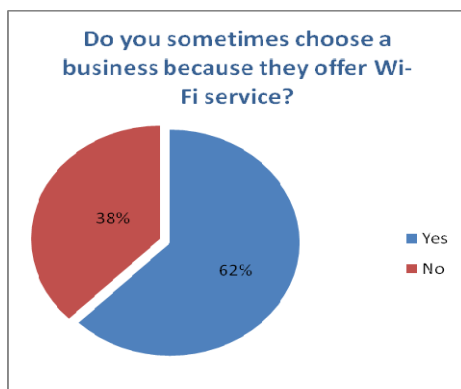
wireless devices and their wireless expectations may yield some additional useful information.

Question 1



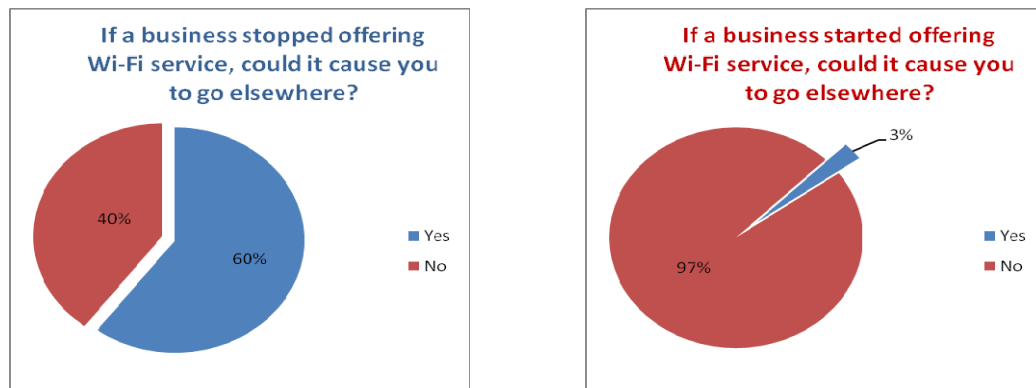
There are several interesting things to note from this question. Nearly four times as many people have used Wi-Fi than haven't. That alone is a indicator that Wi-Fi has become a mainstream conduit for information. The difference between Wi-Fi use for males and females is considerably shifted toward the males. Nearly three times as many females have not used some kind of Wi-Fi compared to males. Not unexpectedly, age seems to have an affect on usage seeing as how the two oldest age groups have the lowest yes responses with no responders over the age of 65 having used Wi-Fi. Location and frequency of eating out don't seem to have any direct affect, other than the fact that 100% of responders outside of the U.S. answered "yes". This shows that Wi-Fi usage is not exclusivly an American phenomenon.

Questions 2 & 5



Remember, the answer to the first questions determined the next four questions presented. The questions presented to "yes" responders have blue chart titles while "no" questions have chart titles in red. The second question for both sought to determine the draw or deterance that Wi-Fi service may have

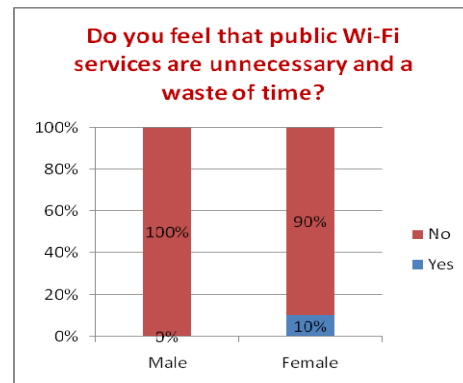
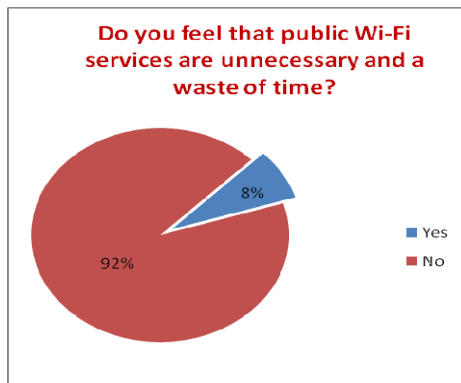
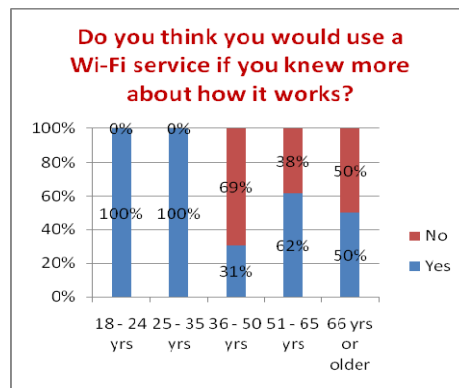
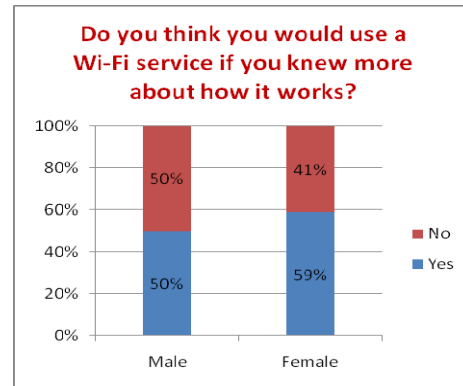
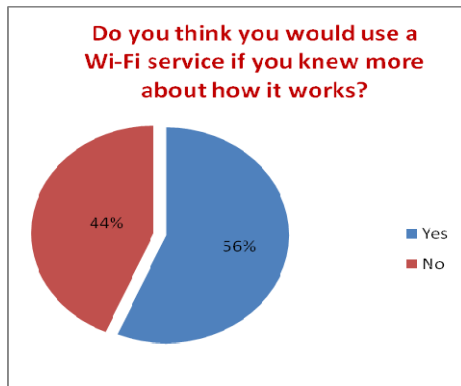
towards customers. From the charts above, it is clear that offering Wi-Fi is far more advantageous. While 62% of “yes” responders said they actively seek out businesses that offer Wi-Fi, only 3% of of “no” responders said they actively seek out business that do not offer Wi-Fi. Clearly, Wi-Fi draws far more customers than it repels.



The last dissimilar question for both groups sought to determine what affect removing or adding Wi-Fi service would have on existing customers. For those who answered “yes” to question 1, 60% said they may take there business elsewhere should a business stop offering Wi-Fi service. For those who answered “no” to question 1, only 3% said that they would take their business elesewhere should a business start offering Wi-Fi service. Again, these responses show that there is much to gain and little to lose for businesses that choose to offer Wi-Fi service to customers.

Because the responses to these questions were so lopsided, further breakdown by gender, age, location, and eating out do not reveal any additional insight (all of the survey results can be found in the appendix).

Questions “No” 3 & 4



Third and fourth questions asked of respondents who have never used Wi-Fi were designed to gauge their interest in adopting the technology. The responses show that even those who have not used Wi-Fi are at least curious.

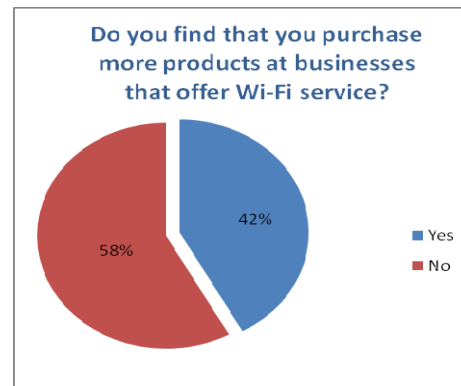
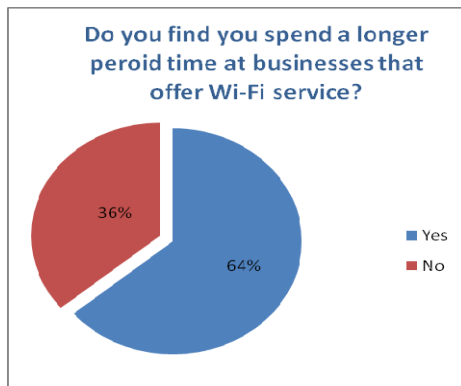
Overall, 56% indicated that they would use Wi-Fi if they know more about it.

When compared by gender, more female than males (59% to 50%) answered “yes” to this question. This may explain the large disparity between males and females to the first question of the survey. Perhaps this indicates that males, in general, are more knowledgeable about Wi-Fi and therefore use it more.

When this question is broken down by age, it is clear that younger users are more eager to learn about Wi-Fi. This is not to say that older responders are completely uninterested. The two highest age groups had 50% or more answer “yes”. This question shows that younger people and females may only need more information and opportunity to become regular Wi-Fi users.

For the small group (8%) who answered that they think Wi-Fi services are unnecessary and a waste of time, all were female. These participants made up only 10% of the female responses. This shows that while somewhere around 50% of responders don’t think they would ever use Wi-Fi, most still felt that it is a worthwhile technology, even if they don’t completely understand it.

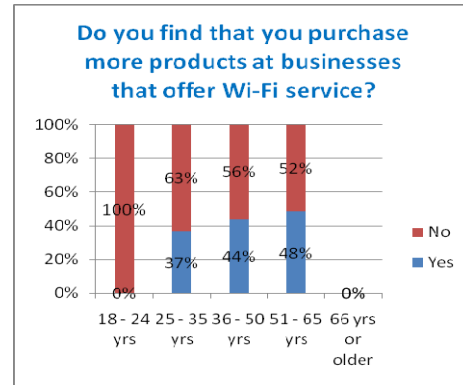
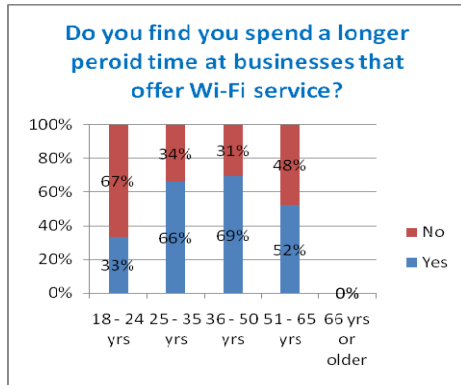
Questions “Yes” 3 & 4



These questions focus on the real reason businesses have for offering Wi-Fi services to customers, the bottom line. Obviously, a business want to attract more customers but without actually making a sale those added customers have no impact on the success of the business. For those responders who have used Wi-Fi, 64% said that they spend a longer amount of time in the store while only 42% said that they actually purchase more products.

While both of these numbers may appear to add value to a business, they may be deceiving. If 64% of customers are staying in the store longer but only 42% are actually purchasing more products this means that 22% are just hanging around surfing the internet and not contributing to revenue. If a business is large and has plenty of space for customers to loiter, this may not be a bad thing. However, if a business is small, those customers may be using space that could otherwise be filled by paying customers. It may even be driving customer away because the business is perceived to always be crowded. Obviously, Wi-Fi

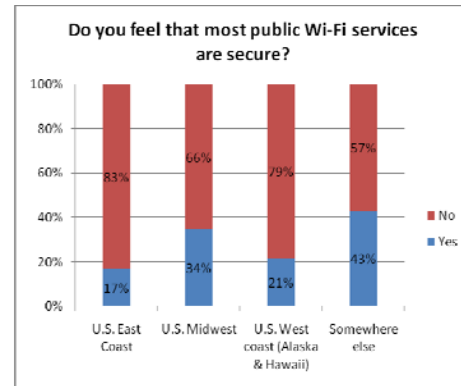
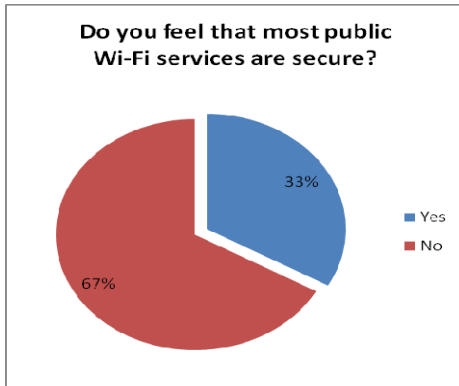
service could be viewed as more successful in generating revenue if these to measurements, time spent and products purchased, had closer values.



No significant difference was found when this question was broken down by gender, location, or frequency of eating out. However, as the charts above show, age does show a significant drop off for converting sales in the 18-24 year category. Responders in this age category said they spend more time in businesses that offer Wi-Fi only half as much as the other age groups. Furthermore, no one from this age group said they purchase more products. This should give pause to business who's product target this age range when considering adding Wi-Fi service.

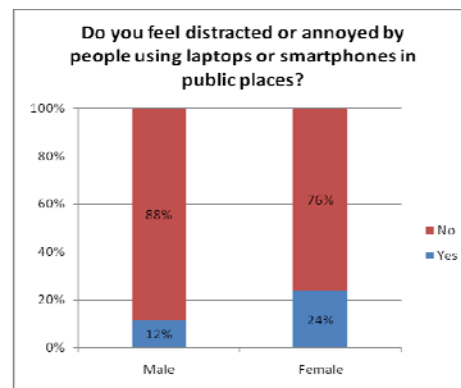
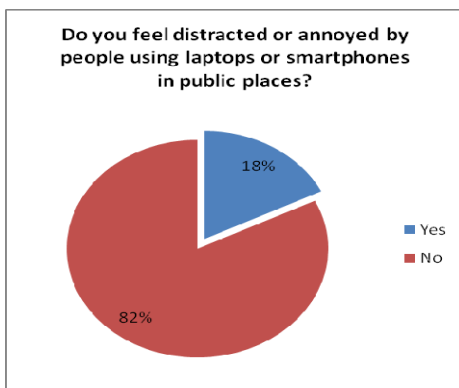
Question 6

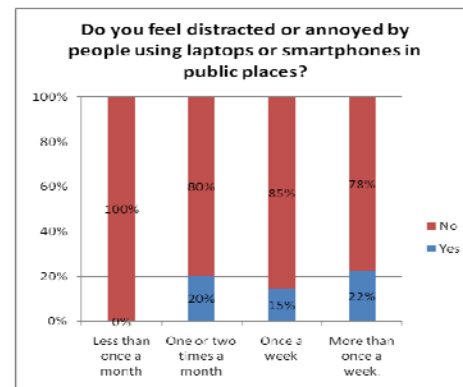
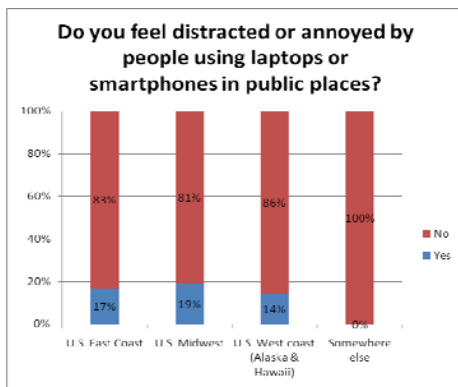
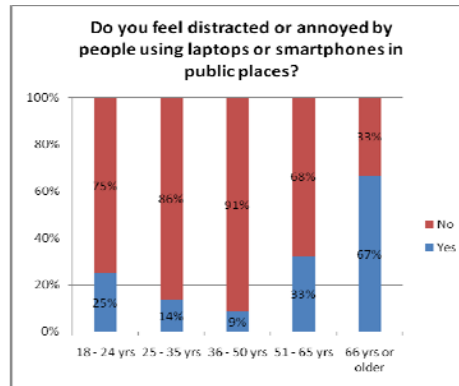
The rest of the questions were asked to all 175 survey participants. This question sought to determine the comfort level of users exposing personal data on wireless networks.



Although an overwhelming majority (and rightly so) do not think Wi-Fi services are secure in general, there are some significant differences when compared by geographic location. Responders from outside the United States were far more trusting of their Wi-Fi connections and within the U.S., the Midwest had a higher opinion of wireless security than those from the East and West coasts.

Question 7



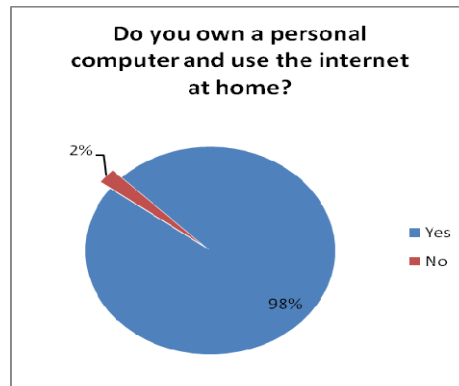


This is a questions that we all can relate to. How much have we gotten used to hearing other peoples phone conversations or sitting next to someone for three hours on an airplane while the work on their laptop? According to the responses for this question, it seems like people are overwhelmingly accepting. Perhaps this is because most people have these devices and want to use them and so they must be tolerant of others in the same way.

A few results to note. Again, gender seems a significant delimiter. Twice as many females said that they are annoyed by smart phones or laptops than males. Not surprisingly, those 66 years or older also answered yes to this question more than twice as much as any age group. None of the responders

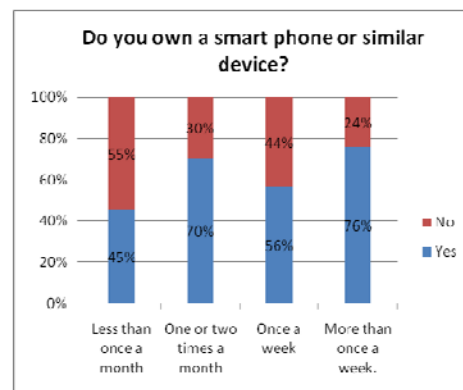
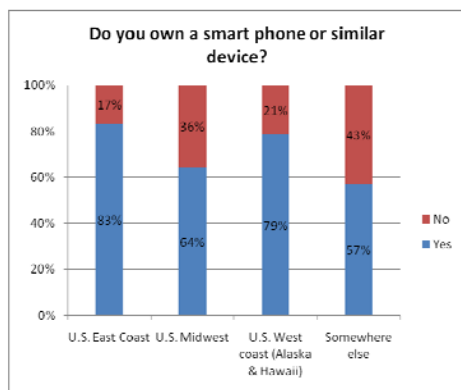
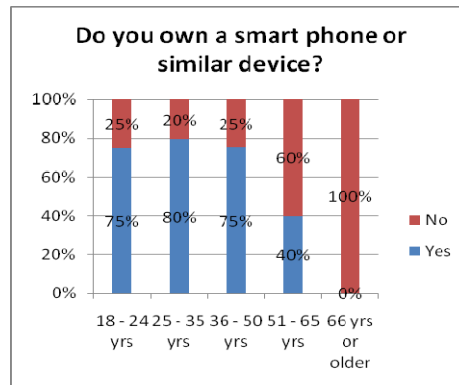
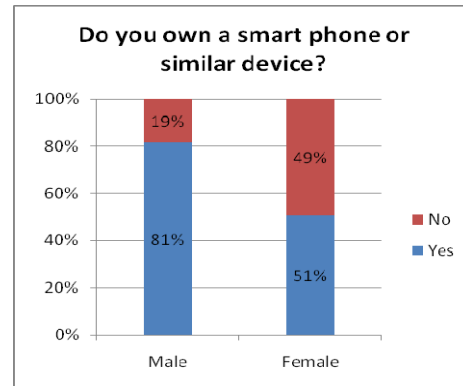
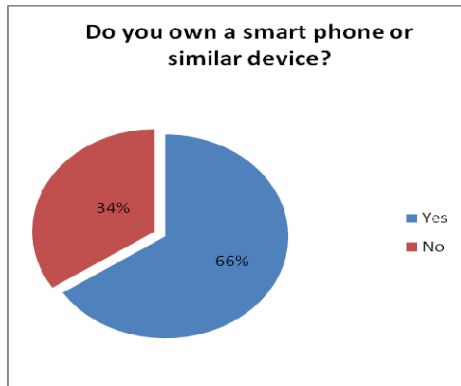
from outside the U.S. answered yes. None of those who said they ate out less than once a month answered yes to this questions while the rest answered yes somewhere around 20% of the time.

Question 8



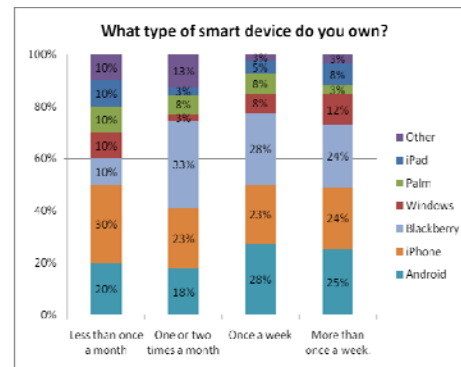
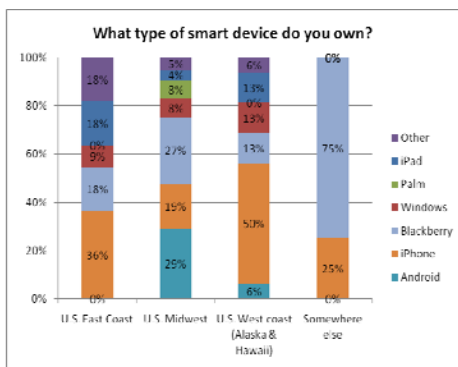
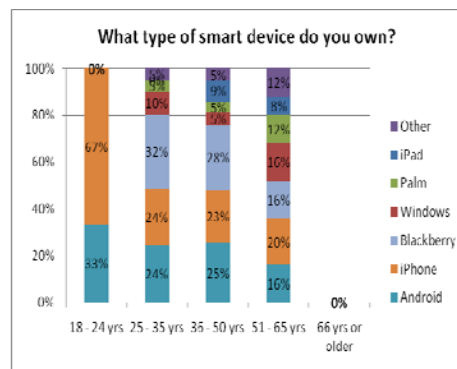
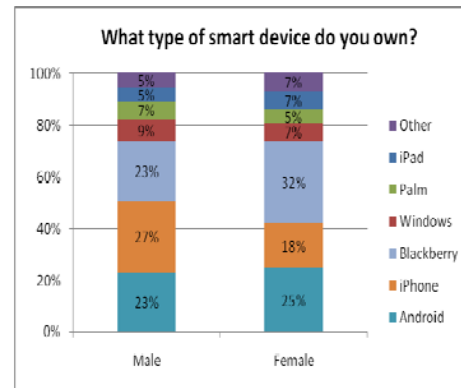
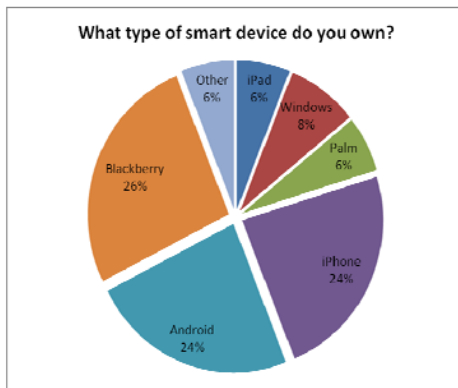
The responses to this question show that we are truly living in the internet age. Because 98% of responders answered yes to this questions, breaking the results down by any of the demographic categories does not yield any further significant information. Almost everyone, male, female, young, old, american or not, is connected to the internet on a daily basis. There is no question that the internet has changed the world, forever.

Question 9



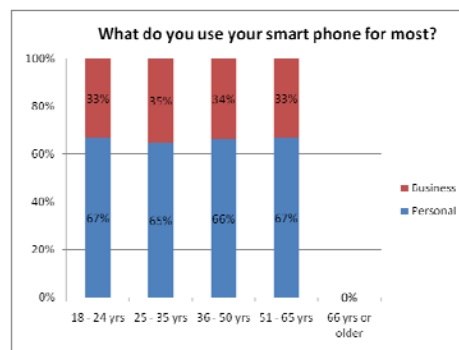
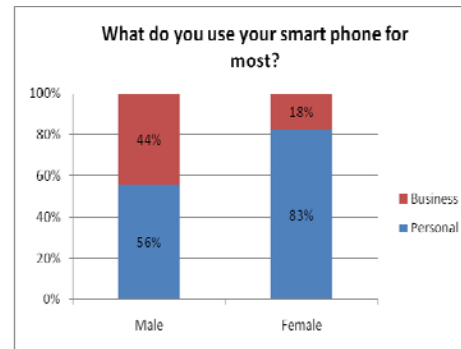
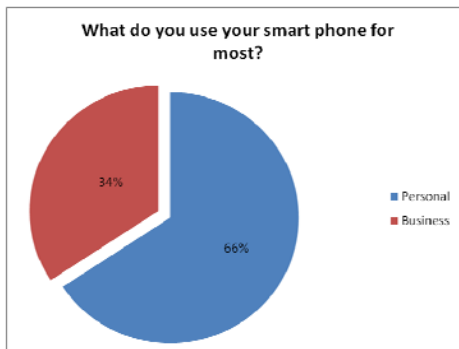
The responses to this question show the recent proliferation of handheld devices. Despite only being available for the past few years, 66% of the people who responded to this survey said they own at least one of the devices. Again,

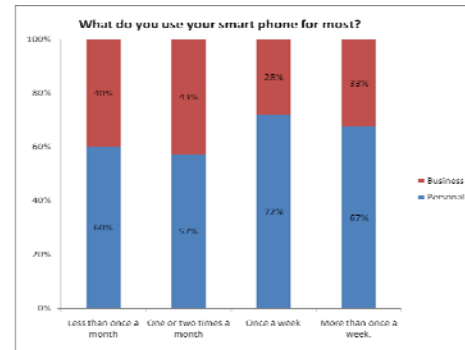
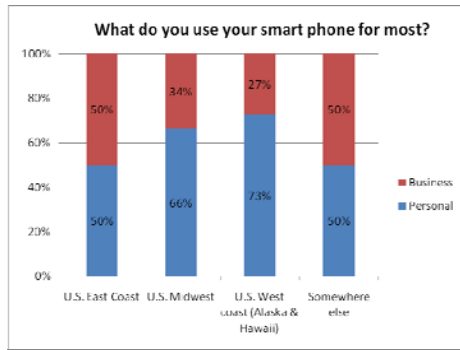
males seem to be ahead of females in adopting this technology by a 30% margin. Younger users also appear to dominate showing a 35% drop off for those aged 51-65 years and no users over the age of 65. Location and frequency of eating out do not show any effect on owning a smartphone.



Participants who own smart phones were asked what types of devices they own. As expected Android, iPhone, and Blackberry were the dominant players overall. For males and females, most of the brands were represented equally except males appeared to prefer iPhones while females favored Blackberries. Responders between the ages of 18-24 years were exclusively Android and iPhone users. Somewhat surprisingly, those outside the U.S. were exclusively iPhone and Blackberry users with Blackberry dominating at a 3 to 1 ratio. Again, frequency of eating out did not reveal any significant trends.

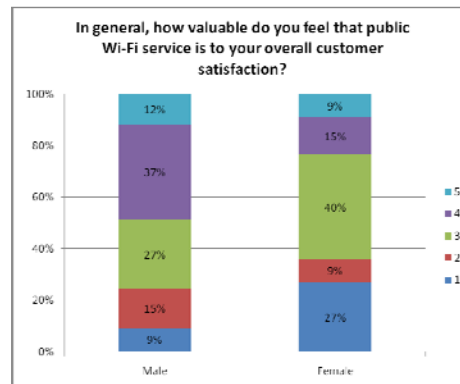
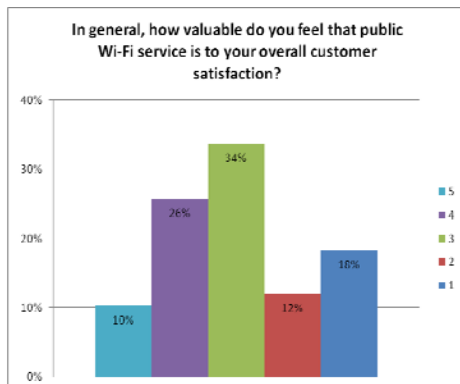
Question 10





Across the board, all groups responded that they used their smart phones for personal reasons more than business. Again, gender seems to be the most significant dividing factor in smart phone use with 83% of females saying they use their smart phones primarily for personal reasons compared to only 56% of males. Frequency of eating out did show a slight increase for those who said they ate out once a week or more.

Question 11

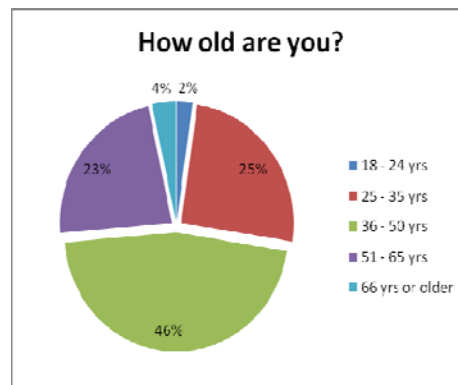
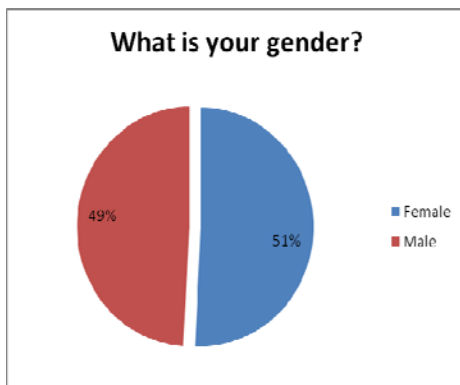


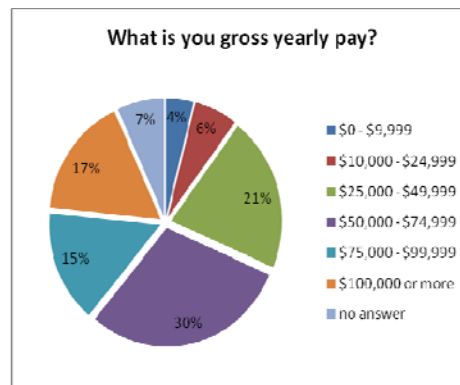
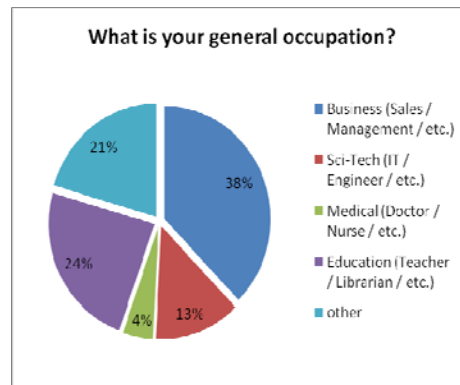
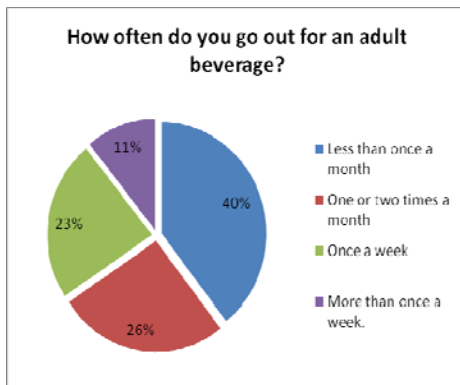
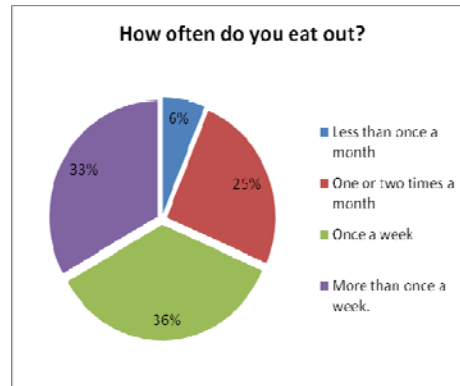
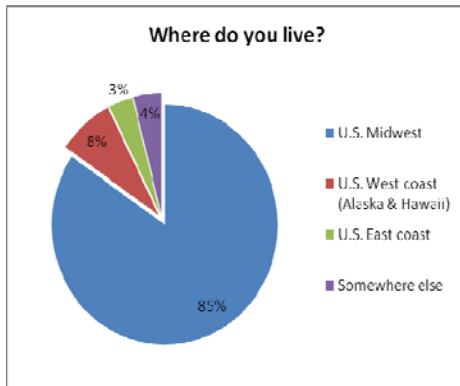
When asked to rate how important Wi-Fi service is to their customer satisfaction, (1 = not important to 5 = very important) 70% responded with a score of 3 or higher and 10% responded with a score of 5. This is very

significant because it shows that Wi-Fi service shows at least some value to a vast majority of potential customers. For males, 49% responded with a score of 4 or higher compared to 24% of females and only 9% gave a score of 1 (not important) compared to 27% of females. Again, this shows that males seem to value the availability of technology more than females. In fact, more males (12%) gave a score of 5 (very important) than gave a score of 1.

Questions 14 through 20

The remaining questions provided the demographic data used to study the previous questions. Some of the questions were not used in this study. These questions do not provide any direct information on the topic of wireless computing. However, the following charts are included to give an idea of the diversity of the survey participants.





Question 21

The final question of the survey asked for people to share any thought they have, good or bad, about wireless technology. Below are some of the more

insightful, if not entertaining, responses. When people are free to speak in their own terms, you truly get an understanding of their opinions.

“It scares the hell out of me. I am fairly certain that it causes cancer.

However, it seems to be the way of the world and I live in the world, so be it.”

– U.S. Midwest Female, 36-50 years old, Teacher.

“Wireless should be everywhere. You never know when it will be useful.

This is especially true when hosting fantasy sports drafts at restaurants, or when the restaurant is attached to a hotel.”

- U.S. Midwest Male, 36-50 years old, Information Technology.

“I feel that use of smart phones, etc. in public places is rude and therefore I am totally against it.”

- U.S. Midwest Female, 66 years or older, Hospitality

“I'd pay a few dollars more in taxes per year to make wi-fi available anywhere.”

- U.S. Midwest Male, 36-50 years old, Designer

“I sat beside a young man with an I-phone on a bus and watched him work the screen urgently for several minutes. Finally, I asked what he was doing. He said he was trying to get the weather. I looked out the bus window and told him it was raining.”

- U.S. Midwest Male

Survey Summary

The survey results show that there are great similarities and great differences in the way people perceive and use wireless technology. One thing that all respondents had in common was an awareness of the technology, which shows how deeply it has penetrated society globally. What does this mean for the idea of integrating wireless technology with food service? It means that it is inevitable. Breakthroughs may not come in the next few years but they will come. People will feel as comfortable ordering lunch or signing their credit card receipt on a smartphone as they currently are checking email or reading an online book.

The final section of this report puts forth a high level design for a wireless network in an actual restaurant. This design does not simply replace cash registers with iPads. Rather, it seeks to redefine the way a wireless restaurant could function, the same way that wireless technology has redefined the functions in our daily lives.

Wireless Network Design

This design for a wireless network for Restaurant X seeks to meet two separate sets of needs, the needs of the business and the needs of its' customers. For the business, the network should allow employees to provide an increased level of service, gain added insight into its operations, and be easy to maintain and upgrade. For the customers, the network should provide internet access and allow direct interaction with the business itself.

In order for employees to provide an increased level of service, they should be more accessible to the customers and have as much information at their fingertips as possible. Both of these goals can be accomplished by enabling each server with a wireless device capable of placing orders, checking on order status, and billing the customer without ever having to leave the table. In fact, this design requires that servers never leave their assigned sections. Their only function is to be available to the customers.

To gain insight into its operations, the more information that can be collected about every aspect of the business, the better. This includes the usual metrics of food and beverage sales but with a wireless system it can also include information on the time it takes for tables to turn over, times which certain products are more popular, wait times for customers to be seated, and much more.

To make the system easy to maintain and upgrade, using off the shelf hardware make sense for a couple of reasons. Cost is an obvious issue with proprietary systems because it essentially eliminates competition once a particular vendor is chosen. Customers are locked into upgrades and features decided by the vendor. Availability is another issue. With proprietary systems, customers usually have to order products in advance and if they require urgent delivery, it usually comes with added charges.

Off the shelf hardware effectively solves both of these problems. Usually, the price of retail products decrease the longer they are in the market as with the case of plasma televisions and blue ray players. Also, replacement hardware can be purchased retail stores which make them available to the business owner immediately.

Giving customers internet access is as simple as ordering business class internet service and purchasing a couple of wireless routers. Allowing customers to interact directly with the restaurant is another story. Decisions on what products to offer and how to collect payment will be addressed. The advantage to the business is that customers become their own servers, essentially creating a self-service restaurant. Customers are happy because they can order food or drinks whenever they like and don't have to wait for a server to process their check. Business owners are happy because they can operate with less staff and have higher customer satisfaction.

Hardware

The hardware required for this design is as follows. Two Dell PowerEdge T310 tower servers will comprise the application servers, data storage, and internet gateway. These servers should be identical replicas so that if one fails, the other can handle all operations until the faulty unit can be fixed or replaced. These servers contain a single Intel Xeon dual core 2.4 GHz processor, 4GB RAM, and a 2TB hard drive for under \$1,000 each.[19]

Wireless connectivity will be accomplished via two or more D-Link DGL-4500 802.11n routers. This router is designed for gaming, so it can handle many connections and large amounts of traffic simultaneously at up to 300Mbps. Two wireless frequencies are supported, 2.4 or 5GHz, enabling division between customer traffic and business traffic and comes with 3 external reverse SMA dual band antennas for under \$175 each. [20]

Employee access to the network and business application is the most innovative part of this design and also the piece that changes traditional restaurant operations. Each server will have their own iPad for entering orders and there will be two iPads stationed permanently, one at the host station and one behind the bar. In addition, customers will be given the option of receiving their bill directly on their smartphone or by an iPod touch delivered directly to their table. In either case, customers can use their credit cards to pay their bill and complete their transactions without further interaction from the server.

The 16GB iPad version with 802.11n Wi-Fi capability will more than meet the requirements for this system. The iPad has a 9.7 inch LED-backlit touch

display and weighs only 1.5 pounds. This is small enough to fit in an apron pocket and be carried by servers during their entire shift. The battery allows for up to 10 hours of continuous operation and can be fully charged in less than 4 hours. These units are priced at \$499. [21]

The 8GB iPod Touch version with 802.11n Wi-Fi capability will be sufficient to support the payment application. The iPod Touch has a 3.5 inch touch display. The battery allows for up to 40 hours of continuous operation and can be fully charged in less than 4 hours. These units are priced at \$229. [21]

There are existing applications for the iPad and iPod touch to process credit card payments. The app that has been selected is the “Credit Card Terminal” by Inner Fence, LLC. This app processes all major credit cards and supports customer signatures. The price for the app and included services is \$25 per month plus a \$0.25 + 1.74-3.79% processing fee per transaction. [22]

Staffing

With the addition of this wireless network, Restaurant X will also change their staffing structure. On a typical Saturday night, the front of the house requires 7 servers, 2 hosts, and 2 bartenders. This system changes the roles of these positions and requires a different staffing structure. Servers will no longer be expected or allowed to leave the table area. Their main purpose is to be available to customers at all times. With their iPad and wireless connection, they

will be able to place and track the progress of orders without having to walk to the kitchen or visit a stationary computer terminal.

Bartenders' duties will remain largely unchanged by the wireless network. Their job already requires them to always be behind the bar to make and deliver drinks to the customers. In a way, the duties of the bartenders and the servers become almost the same, with emphasis on availability to the customer.

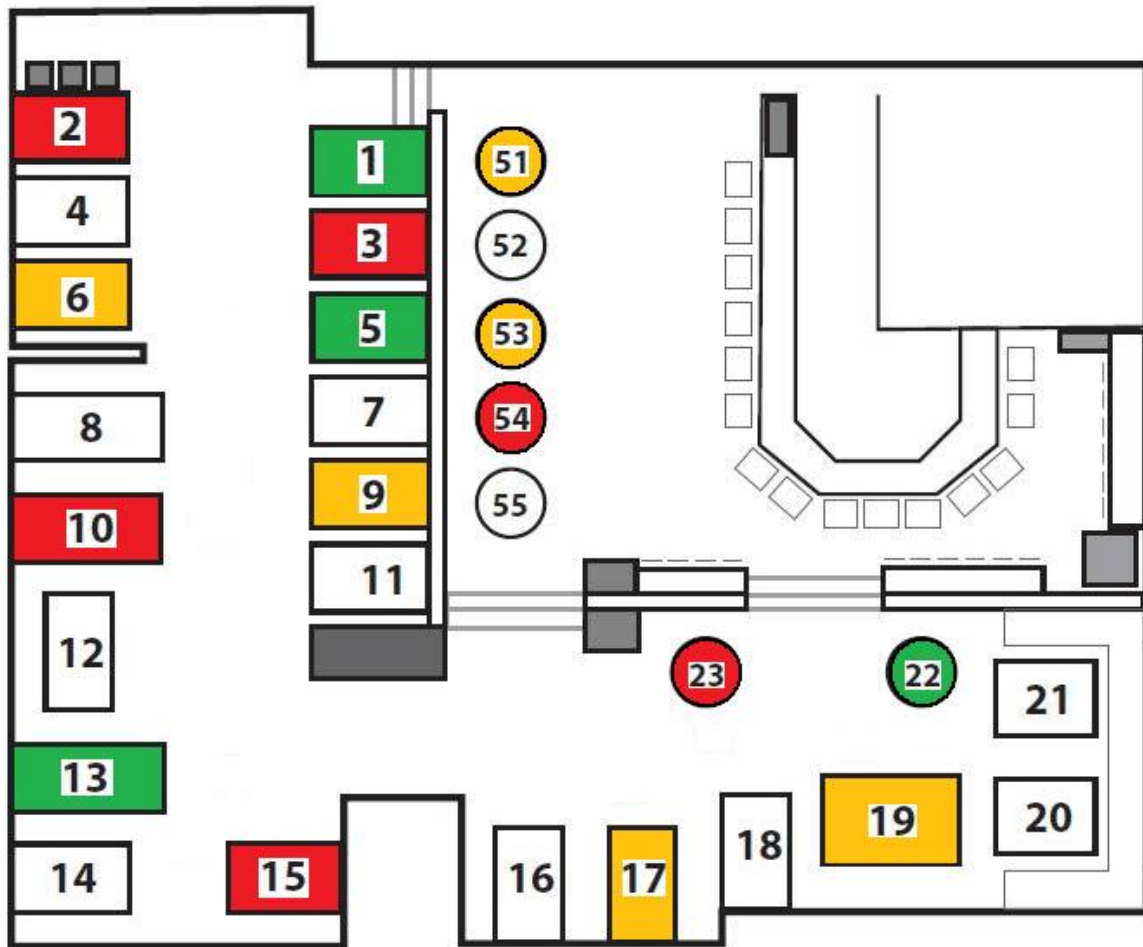
The duties of the hosts will be expanded in the new system. Not only will they be responsible for seating customers but they will also be charged with running drinks from the bar and even food from the kitchen when necessary. Hosts will be much more updated on the status of tables through the iPad located at the host station. They will be able to see the status of every table in the restaurant including what tables are open, what tables have placed orders, what tables have received their orders, what tables have received their checks, and what tables have paid and will probably be leaving soon. The system will manage all of the table states and with the information on waiting customers (how many and in what groups) will plan their seating. When there is an available table or tables, the system will notify the host of what group to seat and where.

Let's examine one common situation we have all probably been faced with. The restaurant is full and a group of 12 people enters the restaurant for dinner. Normally, the host would have to provide the group with their best guess on their waiting time, but let's face it, how do they really know? The host is doing

their best to guess what tables may leave at the same time so that three tables can be pushed together or some other similar scenario. With this system, the host can input the group size and be given a more accurate time estimate based on actual states of tables analyzed by the system. The host can even give real, accurate updates to the group if the original estimate changes. The result is improved customer satisfaction by delivering a more accurate estimate of wait time.

The following image shows the main application display for the host. Each of the tables is coded with a different color depending on its state. White means that the table is unoccupied. Red means that the table has been seated but no orders have been placed. Orange means that the customers have received their food. Green signifies that the table has paid their bill and will soon be available.

Figure 1 - Host Seating Chart

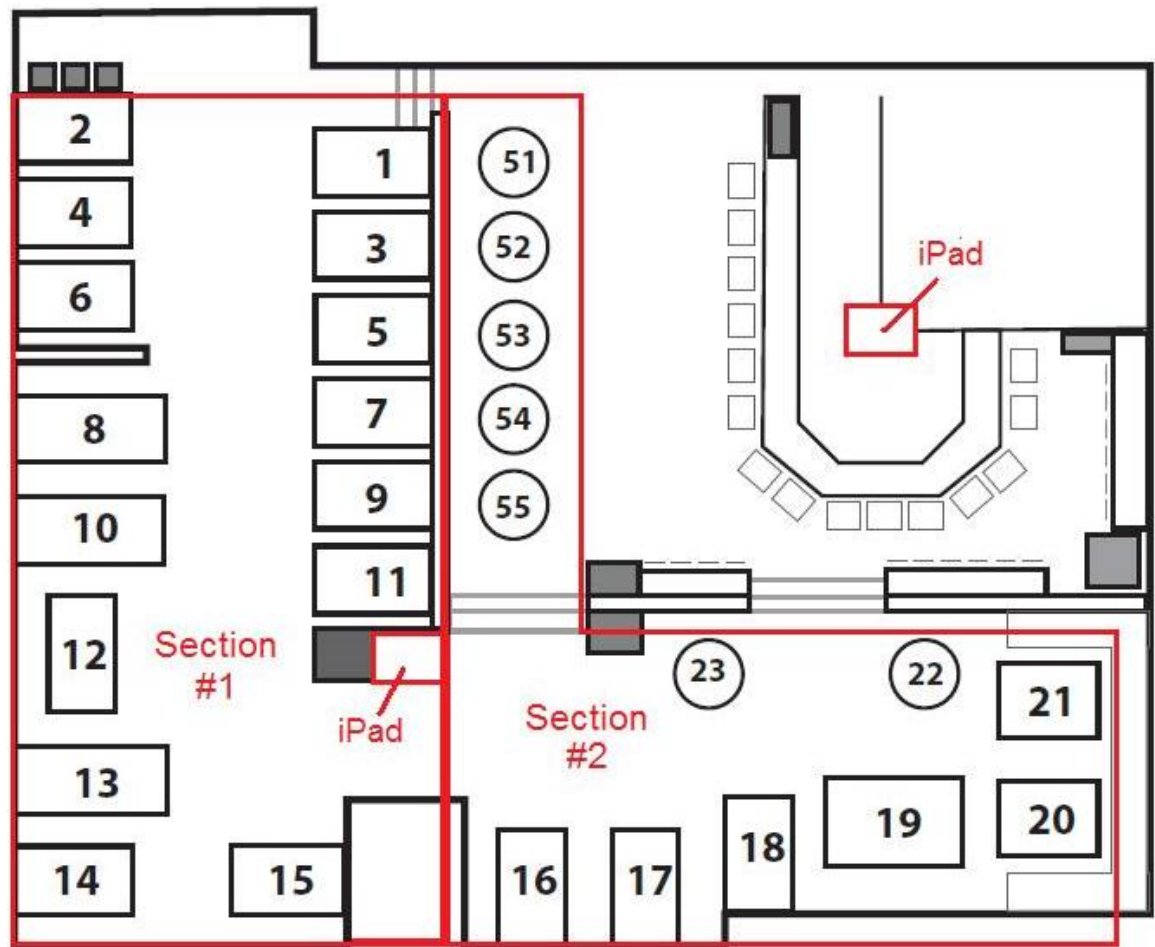


Each table can also be touched to find more details such as the amount of time the table has been occupied, the status of their order if it has not yet been delivered, and the anticipated time the table will become available. Hosts will also be able to process payments and to go orders paid by credit card.

Since they will not be required to run food from the kitchen, fewer servers will be required to serve the same number of tables. Instead of assigning between four and six tables to a server, only three servers will be required for the

entire restaurant. Two servers will be assigned to sections while the third will “float” around the entire restaurant, providing services where necessary. The figure below shows the assigned sections and locations of the permanently stationed iPads for the host and bar.

Figure 2 - Server Sections



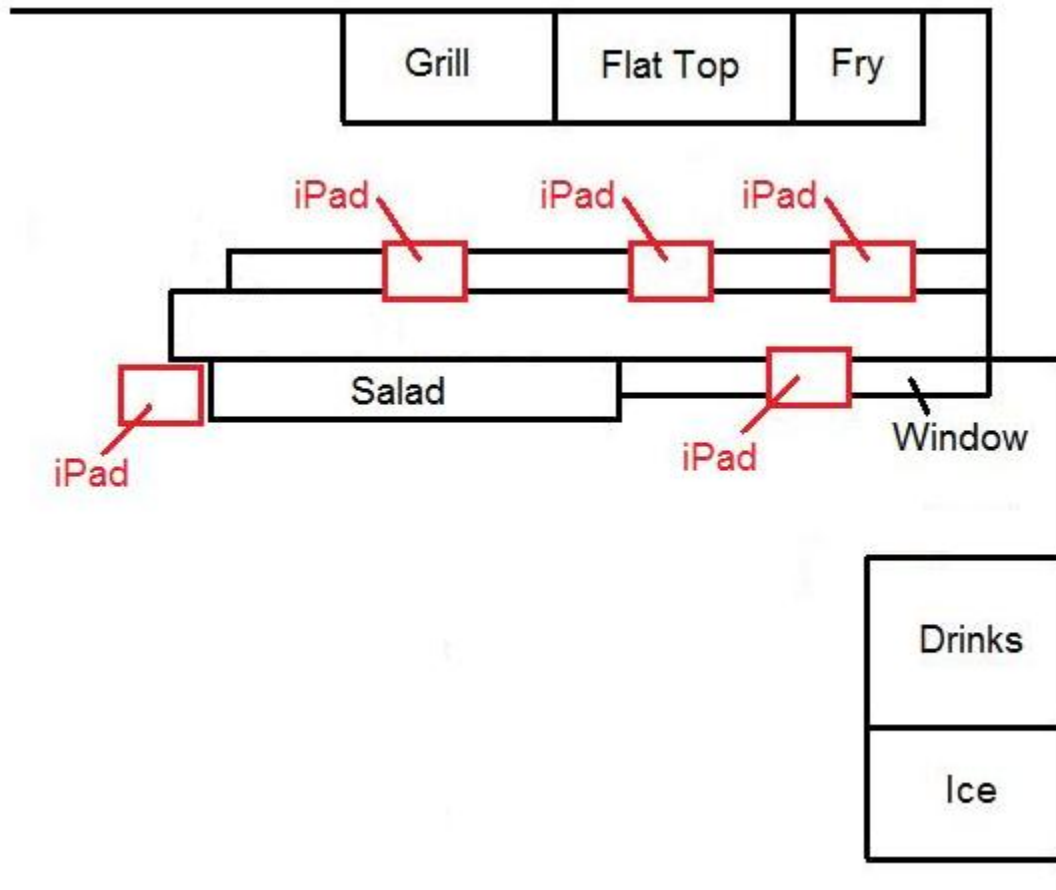
Food and drink delivery from the kitchen will be performed by “runners”. The runners’ jobs are to deliver food and pre-bus tables on their way back from the front of the house as well as help the servers with any special requests like

boxing leftovers to go. At times of low volume, when there are only a few tables occupied in the restaurant, runners will not be necessary and the servers will run their own food. However, there should be at least one server in the front of the house and available to customers at all times.

Food preparation is mostly unaffected by the new system. The only major change will be how the kitchen staff receives orders and how those orders are filled. Five iPads will be installed in the kitchen area, three on the cooking line, one near the salad station, and one at the “window”. Instead of the entire order being printed together on a piece of paper, the order is split up and sent to the corresponding iPad depending on which stations are required. The cook receives the new orders, prepares the food, and marks the food as ready by touching the order on their individual iPad.

When all components of an order are ready, the order is sent to the iPad at the window where the expeditor puts all of the food items together and the food is taken to the table by a food runner. In the case of appetizers, salads, and drink orders, the order is immediately filled and taken to the table. The system will even delay main course food orders until the appetizer has been delivered or for a specific amount of time to avoid food being delivered to the table at the same time as the appetizer.

Figure 3 - Kitchen



Wireless Network Summary

The goal and the approach of this system are simple. Increase customer service by gathering as much information as possible and getting that information to the correct resources. By doing this communication becomes more streamlined. The host knows what tables are occupied and when they will become available, the servers are able to stay in touch with customers at all times, the kitchen knows what to make and when to make it, and management

can study how all of these areas are performing and make adjustments if necessary.

Chapter 5 Suggestions for Additional Work

The opportunity for additional work is available in two areas. First, and expanded and more detailed survey of Wi-Fi users which covers a wider audience and second, a cost benefit analysis for the wireless network described in this project or one similar to it.

The expanded survey should aim to include more responses from outside the U.S. Midwest region and a larger sample on the whole. By gathering more information from the rest of the United States and especially other countries, a more global view of current Wi-Fi usage could be analyzed.

The benefit of this information would be an understanding of global wireless usage. Since the internet spans the entire globe, it makes sense that wireless networks are used differently. Because of an infrastructure much smaller than that of the United States, many countries depend on wireless networks as the major point of access to the internet.

A cost benefit analysis of the wireless network described in this project would highlight the true value added to a business. Perhaps, for now, this approach only makes sense for large restaurants or restaurant chains and may be too high of a capital investment for smaller businesses. Or, are the advantages in customer service and efficiency enough to justify the cost at any level?

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Appendix I – Survey Results